U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—MILTON WHITNEY, Chief.

IN COOPERATION WITH THE IOWA AGRICULTURAL EXPERIMENT STATION,
C. F. CURTISS, DIRECTOR; W. H. STEVENSON, IN CHARGE
SOIL SURVEY.

SOIL SURVEY OF MITCHELL COUNTY, IOWA.

BY

W. E. THARP, OF THE U. S. DEPARTMENT OF AGRICULTURE,
IN CHARGE, AND KNUTE ESPE, OF THE IOWA
AGRICULTURAL EXPERIMENT STATION.

THOMAS D. RICE, INSPECTOR, NORTHERN DIVISION.

[Advance Sheets—Field Operations of the Bureau of Soils, 1916.]

WASHINGTON:
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1918.

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LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF SOILS,
Washington, D. C., August 30, 1917.

SIR: Field operations of the Bureau of Soils for 1916 included a soil survey of Mitchell County, Iowa, undertaken in cooperation with the Iowa Agricultural Experiment Station. The selection of Mitchell County was made after conference with State officials.

I have the honor to transmit herewith the manuscript and map covering this work and to recommend their publication as advance sheets of Field Operations of the Bureau of Soils for 1916, as authorized by law.

Respectfully,

MILTON WHITNEY,
Chief of Bureau.

Hon. D. F. HOUSTON,
Secretary of Agriculture.

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SOIL SURVEY OF MITCHELL COUNTY IOWA.

By W. E. THARP, of the U. S. Department of Agriculture, In Charge, and KNUTE ESPE, of the Iowa Agricultural Experiment Station.—Area Inspected by THOMAS D. RICE.

DESCRIPTION OF THE AREA.

Mitchell County is the fourth county from the east in the northern tier of counties of Iowa. It is bounded on the north by Mower County, Minn., on the east by Howard County, Iowa, on the south by Floyd County, and on the west by Cerro Gordo and Worth Counties. The county is rectangular in outline, and is about 23¼ miles long from east to west, and 20 miles wide from north to south. It has a total area of 467 square miles, or 298,880 acres.

In general, the county is a gently undulating plain lying about 1,200 feet above sea level. The western part is crossed by the Cedar River, which follows a northwest-southeast course, the middle part by Little Cedar River, which is nearly parallel with the Cedar River, and the extreme northeastern section by the Wapsipinicon River which flows in approximately the same direction. The larger tributaries of each of these streams enter them from the western side and tend to parallel them. The eastern branches are generally smaller and enter the streams more nearly at right angles.

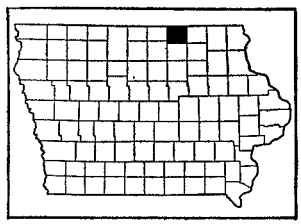


FIG. 1.—Sketch map showing location of the Mitchell County area, Iowa.

The valley of the Cedar River averages less than 100 feet below the surface of the adjacent uplands, and in most places it is less than one-half mile in width. The valley of Little Cedar River above the town of Little Cedar is very narrow, but below this point it is one-half to 1 mile or more in width. The greater part of each of the wider expansions consists of level terraces 20 to 30 feet above the narrow flood plain. The larger terraces are all on the eastern side of the river. The valley of the Wapsipinicon River also is characterized by high terraces on the eastern side. Its flood plain is generally less than one-fourth mile wide and is frequently overflowed.

Throughout the wide interstream areas the surface is generally undulating. Low, broad swells and wide, shallow depressions with-

out definite stream channels, except in the longer ones, are the characteristic topographic features, with occasional low, evenly rounded ridges rising somewhat above the general level. These are most common in the north-central part of the county. East and southeast of Little Cedar the county is gently rolling, and similar topography prevails for a mile or so west of the valley from Brownville to some miles below New Haven.

A very small part of the uplands and terraces is unsuitable for tillage. There are many depressions that are in need of artificial drainage, but the only land unsuited to cultivated crops is the narrow flood plains of the streams and the short slopes that so generally border one or both sides of these alluvial flats.

The larger streams have a fall of several feet to the mile.[1] All the small branches, where the channel is comparatively clear, have a rapid flow.

Water for farm use is obtained mainly by drilling into the underlying limestone. In the eastern half of the county wells are from 200 to 300 feet deep; in the western part adequate supplies of water are usually obtained at depths of 100 to 200 feet. There are a few flowing wells in the Little Cedar River Valley, and many strong springs in the limestone outcrops along the Cedar River.

The county was formed in 1851 and formally organized in 1854. The earliest occupancy of land for agricultural purposes was in 1852, near Osage. A number of Norwegian families located at St. Ansgar in 1853.

A large part of the population of the northern part of the county consists of Germans and Swedes. In the southern part a smaller proportion is of foreign birth. The total population of the county is given in the 1910 census as 13,435, all of which is classed as rural.

Osage is the largest town and county seat. It has a population of about 2,500, according to the census of 1910, St. Ansgar has a population of about 700, and Stacyville and McIntire somewhat over 400 each. There are a number of smaller towns in the county.

The Illinois Central Railroad crosses the western part of the county, and the line of the Chicago Great Western Railway between Omaha and St. Paul traverses the northwestern part. The main line of this system touches the extreme eastern part of the county, and there is a branch line between Osage and McIntire. The Chicago, Milwaukee & St. Paul also crosses the northwestern corner of the county. These roads afford good transportation facilities.

The hogs raised in the western part of the county are shipped largely to Austin, Minn., where there is a packing plant. The

[1] From Otranto to Orchard the Cedar Valley has an average fall of 4.5 feet to the mile; from Riceville to Osage the surface has an average decline of 4.7 feet per mile. Iowa Geol. Survey, Vol. XIII, p. 307.

remainder of the live stock, including the cattle fattened in the county, is marketed mainly in Chicago.

The county roads are well graded, but only a small mileage is surfaced with gravel or stone. All parts of the county are supplied with rural mail delivery and telephone service.

CLIMATE.

According to the records of the Weather Bureau station at Osage, the mean annual temperature in Mitchell County is about 44° F. The average for the summer months is about 68° and for the winter months about 16°. The highest temperature ever recorded at Osage is 103° F., and the lowest, —35° F.

The mean annual rainfall of this area is about 31 inches. The greater part of the precipitation occurs during the growing season. Considering the character of the prevailing soil types the average precipitation and its distribution are very favorable to crop production. Excessive rainfall is more likely to cause damage to crops than drought. The former interferes with tillage and delays the maturing of corn, which is important because of the comparative shortness of the growing season.

While a marked deficiency in rainfall during July and August affects corn and truck crops, short droughts cause little injury to crops where the soils are properly tilled.

There is a normal growing season of 164 days. The average date of the last killing frost in the spring is April 30, and of the first in the fall, October 11. The latest recorded date of killing frost in the spring is May 10, and the earliest date in the fall is September 22. Bluegrass and clover pastures, if not overstocked during the summer, usually retain their feeding value well into December, but the average grazing season hardly exceeds seven months.

The following table is compiled from the records of the Weather Bureau station at Osage:

Normal monthly, seasonal, and annual temperature and precipitation at Osage.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1906).
	°F.	°F.	°F.	*Inches.*	*Inches.*	*Inches.*
December	19.6	51	−24	1.35	0.50	1.55
January	14.0	54	−35	.92	1.95	2.00
February	14.9	58	−32	1.14	.35	1.56
Winter	16.2	58	−35	3.41	2.80	5.11

Normal monthly, seasonal, and annual temperature and precipitation at Osage—Contd.

Month.	Temperature.			Precipitation.		
	Mean.	Absolute maximum.	Absolute minimum.	Mean.	Total amount for the driest year (1910).	Total amount for the wettest year (1906).
	°F.	°F.	°F.	Inches.	Inches.	Inches.
March	29.1	84	−17	1.76	T.	4.17
April	45.4	91	11	2.45	.35	1.65
May	57.1	94	25	4.76	3.49	8.10
Spring	43.9	94	−17	8.97	3.84	13.92
June	66.1	99	34	4.53	.68	2.16
July	70.5	103	42	3.72	.56	5.97
August	68.0	99	37	3.03	5.05	3.21
Summer	68.2	103	34	11.28	6.29	11.34
September	60.0	101	20	3.56	3.27	5.14
October	48.2	87	14	2.42	.65	2.33
November	30.9	70	− 3	1.43	.29	2.80
Fall	46.4	101	− 3	7.41	4.21	10.27
Year	43.6	103	−35	31.07	17.14	40.64

AGRICULTURE.

Corn, oats, timothy, and clover are the principal crops grown in Mitchell County. Wheat and barley are of secondary importance, and rye, flax, and buckwheat are grown to a small extent. Formerly spring wheat was the chief grain crop, but about 30 years ago, after several successive seasons of very low yields, wheat growing was largely discontinued. Flax was once grown quite extensively, but its culture is now restricted to the occasional fields where an earlier planted crop has failed. Buckwheat also is grown as a catch crop in most instances. The acreage in rye apparently has decreased in recent years, while the area devoted to clover and timothy has steadily increased.

The general trend of crop production during the last 30 years is indicated by the following table, compiled from the census reports of 1880 to 1910, inclusive:

Acreage and yield of principal crops, census years 1880 to 1910, inclusive.

Census year.	Corn.		Oats.		Hay and forage.		Wheat.		Barley.	
	Acres.	Bushels.	Acres.	Bushels.	Acres.	Tons.	Acres.	Bushels.	Acres.	Bushels.
1880	22,031	885,044	9,851	815,439	24,273	33,039,	107,124	1,155,142	4,673	113,800
1890	39,418	1,143,109	43,666	1,859,946	46,789	58,823	6,617	102,747	14,560	445,961
1900	55,519	2,253,830	62,893	2,425,660	35 206	57,187	5,782	86,210	17,919	541,280
1910	58,025	2,148,217	79,160	2,499,511	43,723	76,011	725	14,548	8,068	171,935

In addition to these crops, the 1910 census reports 1,805 acres in flax, 1,973 acres in potatoes, and 425 acres in other vegetables. Buckwheat is reported on 324 acres, and rye on about 100 acres.

Corn and oats are grown on every farm. While the soils and climate are favorable to the production of these staples, the importance of these crops is due in large measure to their adaptation to the extensive type of farming and the simple crop rotations commonly practiced. Oats are grown mainly as a cash crop, and are marketed at local elevators. All the corn crop is fed within the county, mainly on the farms where produced.

Some winter wheat has been grown successfully in recent years. Much of the barley grown in the county is fed to stock, usually with other grain. In growing grain for feed some farmers mix wheat with oats.

Hay is produced on a large acreage. The greater part of the hay crop consists of timothy and clover mixed. Some timothy is grown alone, and considerable seed is produced. A small acreage is devoted to clover alone, and some millet and other tame grasses are cut for hay. A considerable area is in coarse forage. As a rule no great difficulty is experienced in securing a good stand of clover after oats, but winterkilling is not uncommon. Where timothy and clover are sown together the former generally maintains itself for several years while the latter becomes thinner or entirely disappears in parts of the fields.

Trucking is an important industry around St. Ansgar. In 1916 about 1,000 acres of Irish potatoes were grown. In most cases the potato fields contain 10 or 15 acres, but there are a few of 50 to 100 acres. The Rural New Yorker and Irish Cobbler are the most popular varieties, and yields range from 50 to 200 bushels per acre. In 1915, 250 carloads were shipped from St. Ansgar.

In 1916 about 150 acres of Red Globe onions were grown. The yields were materially reduced by droughts in July and August, but some fields produced about 110 bushels per acre. Cabbage was planted in 1916 on a total of about 70 acres, mainly in the immediate vicinity of the towns. Snap beans and strawberries do well in the county and are grown to a small extent.

The quality of the truck crops is good. The favorite soil for all kinds of truck is that part of the Carrington silt loam underlain by sand at depths of a few feet, where at slightly greater depths the lime rock is usually found.

Ginseng growing is locally important near St. Ansgar. The industry was started in a small way about 17 years ago. There are now 3 acres under artificial shade, and 6 acres, near the river, in clean,

well-cultivated beds in the timber. About seven years are required after seeding until the roots reach marketable size. Effort is made to grow the roots under as nearly natural conditions as possible.

Less than 100 acres of sugar beets were grown in 1916; a larger acreage was annually grown while a sugar-beet factory in Bremer County was in operation.

On nearly all the farms there are small apple orchards. The 1910 census reports a total of 28,205 apple trees in the county. The Duchess, Wealthy, and a few earlier varieties seem best adapted to this region. Cherries and plums do well, and there are a few peach trees in the county.

The following table gives the relative value of farm products in Mitchell County, as reported in the census of 1910:

Value of agricultural products, arranged by classes.

Product.	Value.
	Dollars.
Cereals	2,097,998
Other grains and seeds	71,252
Hay and forage	421,152
Vegetables	95,369
Fruits and nuts	23,768
All other crops	102,944
Live stock and products:	
Animals sold or slaughtered	1,684,838
Dairy products, excluding home use	351,268
Poultry and eggs	254,054
Wool, mohair, and goat hair	7,255
Total	5,109,898

Dairying is an industry of considerable importance in Mitchell County, and creameries are in operation at Osage, St. Ansgar, and a number of other points. A considerable number of cattle are fattened, but this business is not so popular as in former years.

Hog raising is the most important line of animal industry. On most farms the sale of hogs is the largest source of income. On a few farms in each township there are small flocks of sheep. Occasionally feeders are imported and fattened. Aside from the sheep so imported, the number in the county is probably less than that reported in 1910.

The following table, compiled from the 1910 census, gives the number of domestic animals sold or slaughtered and the number of live stock in the county:

Number of domestic animals sold or slaughtered and number of live stock in Mitchell County, 1910.

Domestic animals sold or slaughtered:	
Calves, sold or slaughtered	1,340
Other cattle, sold or slaughtered	21,837
Horses and mules, sold	1,000
Swine, sold or slaughtered	39,450
Sheep and goats, sold or slaughtered	5,313
Number in county on farms and ranges:	
Milch cows	13,386
All other cattle	26,774
Horses	11,046
Hogs	41,632
Sheep	6,928

Farmers do not recognize any very marked difference in the crop adaptations of the principal soil types, and such preferences as they have are usually based upon soil variations due chiefly to differences in drainage. The lateness of wet land, and the inconvenience of using heavy teams and implements in such areas are the factors chiefly influencing the selection of other land for crops.

A considerable part of the land used for corn is plowed in the fall. Nearly all farmers prefer such early breaking of corn land, wherever practicable. Both disk and smoothing harrows are used in preparing the seed bed. Nearly all the corn is check rowed, and three or four cultivations are given with riding cultivators. Further tillage with one-horse implements is seldom practiced, nor is it considered advantageous to maintain a dust mulch after the corn is too high for the use of the wheeled implements. Some flint corn is grown, usually on late land, but the bulk of the crop consists of yellow dent varieties.

There is much difference of opinion as to the use of drills in sowing oats and other small grain. Many farmers use a broadcast seeder, and go over the ground twice with a disk and once with a smoothing harrow. Since much of the acreage sown to oats is corn-stubble land and often rather weedy, the latter method doubtless gives more satisfactory results than drilling the seed. Only a few farmers plow for oats.

On nearly all the farms improved machinery of the later designs is in general use. The farm equipment includes manure speaders, hay loaders, and two-row corn cultivators, in addition to the common farm implements. The draft horses are generally large, and 3-horse or 4-horse teams are commonly employed in farm operations. A few tractors have lately been introduced.

Nearly all the farms operated by the owners, and most of those leased to tenants, are well fenced and have other improvements

needed for handling live stock. The barns are generally large, and many silos have been built in recent years.

Some rotation of crops is practiced on nearly all the farms, although not as systematically as might be wished. Oats or some other small grain is grown one year, followed by mixed clover and timothy, which occupies the land 2 to 3 years, as a rule, and is followed by corn. Not more than two successive crops of corn are usually grown on the same land. On the rented farms a larger proportion of the land is used for grain crops than on the farms operated by the owners.

Practically no commercial fertilizer is used. The manure that accumulates during the winter lies in open lots until used on cultivated land. The period between corn planting and cultivation is quite commonly used in spreading manure on grass land, but in some seasons this is impracticable. On most farms there is much loss in fertilizing value of the manure, owing to exposure to the rains.

Farm laborers are paid $30 to $35 per month, with board and lodging. In a few instances higher wages are paid. Where hired by the day during the harvest season, laborers receive $1.50 to $2. Considerable transient labor, consisting mainly of foreigners, is employed on the truck farms near St. Ansgar. The 1910 census reports a total expenditure of $237,264 for labor on the 1,068 farms reporting such expenditure.

The census of 1910 reports a total of 1,729 farms in the county, and the average size is given as 166 acres, about 97 per cent of the total area of the county being in farms. Of the farm land, about 91 per cent, or an average of about 151 acres per farm, is reported improved. Most of the farms range from 80 to 160 acres. Very few exceed 320 acres. The tendency apparently is toward larger holdings.

Since about 1880 the proportion of tenant farmers has gradually increased; the 1910 census reports 32.2 per cent of the farms operated by tenants, and practically all the remainder by the owners. Most leases are for one year. Cash rents vary from $3 to $4 or more per acre. Share rent commonly ranges from two-fifths to one-half of the grain produced, with usually a cash consideration for meadow and pasture land.

There is little desirable farm land offered for sale at less than $100 an acre. The highest price received for farms of average improvement and location is about $150 an acre. Land values advanced very rapidly and considerable land changed hands prior to 1914; since that time the advance in value and the number of sales have not been so great. The 1910 census reports the average assessed value of farm land as $67.92.

SOILS.

Mitchell County lies within that part of northeastern Iowa known geologically as the Iowan drift area.[1] The surface is occupied by materials of glacial origin, and thick beds of limestone of Devonian age underlie all the drift deposits. Except in a few small areas the rock is so deep that it has no direct influence on the soils.

As previously stated, the uplands almost everywhere are undulating to gently rolling; the small areas having a stronger relief are confined to the immediate vicinity of the larger streams. Throughout the uplands, which constitute 77.4 per cent of the area of the county, the immediate surface deposits are quite uniform in character. All the interstream areas were formerly prairie, with occasional small patches of timber. Owing to this uniformity in the original vegetation, similarity of the immediate surface deposits, and the prevailingly smooth topography there are extensive areas of similar or closely related soils. Such variations as occur are caused by differences in local topography, which affect the drainage and influence surface erosion, and by differences in the character of the material immediately below the 3-foot soil section. This substratum has considerable influence on underdrainage and aeration, and is a factor of great importance, not only in the formation of the soil but in the determination of its agricultural value.

Throughout most of the county the substratum consists of brown or light yellowish brown, rather heavy till. Usually it contains considerable sand and more or less gravel, but very little stony material. This coarse glacial debris consists of chert, quartz, granite, and other hard resistant rocks, with seldom any fragments of shale, sandstone, or limestone. The brown, or oxidized, portions of the till seldom show any evidence of free lime when tested with acid. The lighter colored, or less oxidized till lying at greater depths is sometimes calcareous, but usually at such depths that it is doubtful if it affects the 3-foot soil section.

In places instead of the heavy brown till a coarse sand or sandy clay is encountered, or beds of unconsolidated gravel occur. In the north-central part of the county there are large areas in which coarse, brownish sand occurs beneath the surface layer of silt and silty clay.

In some very small areas near the Cedar River the limestone lies within a few feet of the surface. In places the 3-foot soil section rests directly upon the rock, but generally there is an intermediate stratum of clayey till or of sand.

In all areas having these subsurface variations there is a layer of silt, or silty clay, with an average depth in the undulating areas

[1] All references to geology are from reports of the Iowa State Geological Survey.

of about 30 inches. The surface soil to a depth of about 10 to 15 inches, is a black silt loam. The dark color is due to the presence of organic matter, which is mainly black carbonaceous material, finely divided and intimately mixed with the mineral constituents, except in places where extremely slow drainage has favored such an accumulation of this vegetable residue that it forms a mucky or semimucky soil.

The subsoil, or the material extending from a depth of about 15 inches to a depth of about 3 feet, is a brown silty clay loam, somewhat heavier than the soil, retentive of moisture, but almost invariably having a structure favoring aeration. Where such conditions prevail, the land has a high agricultural value. The soil is mapped as the Carrington silt loam, which is the dominant type of the county.

On the low, dunelike ridges in the northern part of the county, the silty surface layer is thinner, and over the crests of these elevations the soil is usually a sandy loam. In the lower areas near these ridges the influence of the sandy substratum is evident in the larger admixture of sand in the soil. These coarser textured types are indicated on the soil map as the Carrington sandy loam and loam.

Wherever the conditions for good drainage and relatively deep aeration are not so favorable there occurs a rather heavy, black, silty loam, underlain by a gray or grayish-yellow silty clay subsoil. The abundant organic matter present often colors the soil to a depth of 15 or 20 inches and gives it a very loose structure. This soil is recognized as the Clyde silt loam. It occurs in depressions in the uplands, particularly where a heavy, relatively impervious substratum occurs at a depth of a few feet. It does not occur in those areas where the sandy substratum prevails.

In the strongly rolling areas the total depth of the silty clay surface layer is less than in the undulating areas, and the brown till, with its higher content of sand and gravel, constitutes the lower part of the 3-foot soil section. There is also less organic matter in the surface soil. On sharp elevations the surface soil is usually a loam or sandy loam with some stony material. These areas are mapped as the Shelby silt loam.

On the east side of the Cedar River Valley at Osage there are several square miles of loess. In its weathered condition this is a brown, silty material several feet deep. It is underlain by coarse sand which in turn rests upon limestone. The topography is rolling or hummocky, and small lime sinks are numerous in some places. On that part of this loessial area formerly covered with timber a dark-brown to brown, friable soil occurs, which is mapped as the Clinton silt loam. East of the limits of the original forest the soil is liberally supplied with organic matter, and is practically identical

with those parts of the Carrington silt loam having a sandy substratum.

The small areas in which a silty clay surface deposit rests upon the lime rock are indicated on the soil map as the Dodgeville silt loam, shallow phase. Strictly residual material from the lime rock is seldom encountered even in the subsoil in these areas.

There is a very limited development of light-colored timber soils on the uplands near each of the larger streams, but the individual areas are small and not well defined. As much of this soil resembles the Lindley silt loam all these areas are so designated on the soil map.

The terraces or high second bottoms in the valleys of the Wapsipinicon and Little Cedar Rivers are occupied by outwash sands and gravels (Buchanan gravels) with a thin covering of silty material. The latter is usually so thin along the extreme riverward margin of the terraces that a shallow, sandy soil with a gravelly subsoil occurs in such situations. But over the greater part of the terraces there is from 2 to 4 feet of silt and silty clay loam, forming a soil of high agricultural value. This soil is classed as the Waukesha silt loam.

The terraces in the Cedar River Valley are not so large nor so well developed as those along the other rivers. The soil ranges from a silt loam to sandy loam, and is more or less variable in other respects, owing to the uneven surface of the terraces. Similar deposits also occur in the very small valleys, and in a few instances in structural depressions not very closely related to the present drainage systems. These soils are included in the Waukesha series, though they show considerable variation from type.

The high terraces in the Wapsipinicon Valley present numerous local peculiarities of drainage, caused by impervious clay strata associated with the gravel deposits. The Chariton silt loam is a distinct soil type derived from this alluvial material.

The flood plains of the streams are comparatively narrow, and the alluvial soils are generally so variable in texture that a satisfactory classification is impracticable. Much of the flood plain is mapped as Meadow, a nonagricultural classification. Where the first bottoms expand into areas of tillable soil, a black sandy soil is usually present. In the widest parts of the Little Cedar River Valley, a moderately heavy silt loam occurs. These rather ill-defined types are correlated with the Cass series.

Small areas of Muck occur in local depressions on the terraces and in the first bottoms, while a few comparatively large areas occur in the upland.

For convenience in the study of their relations, the soils are broadly grouped into series. A series includes soils that are similar

in color, origin, formation, topography, drainage, and other characteristics, but that differ in texture, upon which difference the subdivision of the series into types is based. Texture is determined by the relative proportions of sand, silt, and clay present in the soil. In Mitchell County 11 soil series, embracing 14 soil types, are mapped, in addition to Meadow and Muck.

The soils of the Carrington series are dark brown to black; the subsoils are yellow to light brown and heavier in texture than the soils. These soils are derived from glacial till. The topography is gently undulating to rolling. Neither soils nor subsoils are highly calcareous. The series in this county includes three types, the Carrington sandy loam, loam, and silt loam.

The Clyde series is characterized by dark-brown to black surface soils and drab or mottled gray and yellow subsoils. These soils are derived from the weathering of glacial material deposited in glacial lakes, depressions, or poorly drained areas along streams. Neither soil nor subsoil has a high lime content. Since the soils occur in level or depressed areas, the natural drainage is poor. The Clyde series is represented in this county by a single type, the silt loam.

The Shelby soils are dark brown to almost black, and are usually quite shallow. The subsoils are composed of yellow or brown, sticky sandy clay, often containing coarse sand and gravel. Lime concretions are frequently found in the lower subsoil. The soil is derived from sandy drift. The topography varies from gently to sharply rolling, as the series usually occurs on slopes where the sandy drift is exposed. The Shelby series is represented in the county by the silt loam type.

The types included in the Clinton series are characterized by gray or dark-gray soils and light-brown or yellowish-brown, compact subsoils. The subsoils are not highly calcareous. The topography is rolling to broken, and drainage is well established. The soils are derived by weathering from loess, and occur typically north of the Missouri River in the loess belt along the eastern side of the Mississippi. In Mitchell County the Clinton series includes only one type, the silt loam.

The soils of the Dodgeville series are variable, ranging in color from brown to nearly black. They are usually underlain by limestone at depths of 3 to 4 feet. The subsoil below about 20 to 30 inches, is a compact brown or reddish-brown sandy clay containing rock fragments. In places a stratum of several inches in the lower subsoil consists of residual material, a stiff sandy clay. The soils of this series are usually acid, but the subsoils are either neutral or calcareous. The series is represented in this county by the shallow phase of the silt loam type.

The Lindley soils are usually yellowish brown, ranging from gray to brown. The subsoils are yellowish brown, and in some places faintly mottled with gray. The subsoils are usually heavier than the soils but contain a considerable percentage of sand and gravel. Iron concretions are often present in the lower subsoil. The topography varies from rolling to rather rough. This series is derived by weathering from glacial drift, and occupies the same relative position as the Shelby series, differing from it in the lighter color of the surface soil. The Lindley silt loam is mapped in this county.

The types in the Waukesha series are characterized by dark-brown to black surface soils and light-brown to yellow subsoils. The subsoils are heavier in texture than the soils, but are not compact and impervious. These soils are only moderately calcareous, and the lower subsoil will not usually effervesce with acid. They occur on terraces above present overflow and are well drained. The silt loam member is recognized in this county.

The surface soil of the types of the Bremer series is black. The subsoil is dark gray to almost black or drab, mottled with yellow, brown, and black iron stains. The subsoil is as heavy as or heavier than the soil to a depth of 3 feet or more, and in the heavy types it is tough and plastic. The series is confined to terraces above overflow. The Bremer soils are fairly well to poorly drained. The series is represented by a single type, the silt loam.

The surface soil of the types in the Plainfield series is light brown to brown, and the subsoil light brown to yellow. These soils occur on terraces in the Central States and are composed of reworked glacial material. Neither soil nor subsoil is highly calcareous. The material in the subsoil and substratum has a loose, porous structure. This series is represented by one type, the Plainfield loam.

The types in the Chariton series have soils ranging in color from dark gray to dark brown. The upper subsoil is usually an ashy-gray silt loam or silty clay loam, and the lower subsoil a mottled brown and drab, compact silty clay loam or clay. These soils occur on old terraces above the present flood plains of the streams, and natural drainage is good, except where the impervious subsoil retards percolation. The lime content is low. The Chariton silt loam is the only member of the series mapped in this county.

The Cass series includes types with dark-brown to black soils and a lighter textured, brown or grayish-brown subsoil, which frequently passes within the 3-foot section into loose sand and gravel. Both soil and subsoil are calcareous. These soils are subject to overflow, but drain off rapidly when the floods subside. Two members of the Cass series, the sandy loam and silt loam, are mapped in Mitchell County.

Two miscellaneous types, Muck and Meadow, are found in the county.

The following table shows the actual and relative extent of the various soil types in Mitchell County:

Areas of different soils.

Soil.	Acres.	Per cent.	Soil.	Acres.	Per cent.
Carrington silt loam	222,336	74.4	Carrington loam	3,072	1.0
Clyde silt loam	14,208	4.8	Plainfield loam	1,536	.5
Shelby silt loam	13,952	4.7	Muck	1,472	.5
Waukesha silt loam	10,560	3.5	Cass sandy loam	1,408	.5
Meadow	9,088	3.0	Cass silt loam	1,344	.4
Carrington sandy loam	6,016	2.0	Chariton silt loam	896	.3
Dodgeville silt loam, shallow phase	5,952	2.0	Bremer silt loam	768	.3
Clinton silt loam	5,568	1.9	Lindley silt loam	704	.2
			Total	298,880	.....

CARRINGTON SANDY LOAM.

The soil of the Carrington sandy loam ranges from a dull-brownish sandy loam to dark-gray or black loam. The subsoil of the lighter areas is usually a brown or yellowish-brown rather coarse textured loam, which in the lower part of the 3-foot soil section grades into a relatively loose, brown sand extending to great depth. The subsoil of the heavier and darker colored areas is usually a silty clay loam, carrying more or less coarse sand. At a depth of 30 or 40 inches the material is usually a loamy sand. In nearly all areas of this type the deep substratum is a loose, brown sand.

The content of organic matter in the heavier areas is moderately high. It darkens the soil to a depth of 8 or 10 inches and in depressions to a greater depth. On the higher "points" and ridges the organic-matter content is lower, but seldom so low that the surface soil has the "mineral" brown tint of the middle and lower subsoil.

In all instances the soil is more or less acid, and evidences of lime are lacking. Since the type has a yellowish-brown subsoil similar to that of the Carrington silt loam it is highly probable that there is little difference in the average content of lime or of other minerals. This inference is supported by average crop yields, allowance being made for lower yields in dry seasons on the sandy knolls. The narrow areas in the north-central part of the county are low ridges and the smallest areas are generally mounds of slight elevation.

The areas near the State line a few miles east of Mona are undulating and the soil is generally a black, friable loam. Much of it is similar to the Carrington silt loam. The areas near Bailey and

McIntire are mainly a rather sandy loam, but generally have a moderately heavy subsoil. The drainage is in general good and on a few prominent elevations excessive.

Practically all the Carrington sandy loam is devoted to the production of corn, oats, clover, and timothy. It is a somewhat earlier soil than most of the silt loam and in wet seasons it is more easily handled and the crop yields are as good as on the heavier types. The injurious effects of dry weather are usually confined to the areas of lightest soil. In all places the moisture content of the sandy substratum is higher than would be inferred from its coarse texture.

The value of this type is about the same as that of the Carrington silt loam.

Owing to its rather low content of organic matter it is advantageous to grow clover on this soil at frequent intervals, occasionally turning a crop under. The application of barnyard manure and the incorporation of crop residues should also be employed to keep up the supply of organic matter.

CARRINGTON LOAM.

The soil of the Carrington loam, to a depth of about 10 inches, is a dark-brown to black, mellow loam or silt loam. It contains some medium to coarse sand, but no gravel. The subsoil extends to variable depths, usually about 24 inches, and consists of a yellowish-brown, crumbly silt loam or in some instances a plastic silty clay loam. With increase in depth the comparatively small proportion of sand in the middle subsoil rapidly increases and the lower subsoil is usually a sandy loam or a coarse loamy sand. The substratum consists of a generally coarse, sandy material, not essentially different from the substratum of the Carrington sandy loam or of the lighter areas of the silt loam.

The Carrington loam represents a transitional stage between the sandy loam and silt loam types, and no sharp distinction can be drawn between its lightest variations and the sandy loam, nor a consistent separation made between its heaviest variations and the silt loam. As a rule the more sandy areas of the Carrington loam occur on slight local elevations, while in the depressions and in larger areas where a somewhat uneven topography prevails the soil is heavier and darker colored.

In all instances the drainage and aeration are good, due in large measure to the sandy character of the lower subsoil and substratum. In some places small ponds bordered by muck beds are found, but there are few well-defined watercourses. There is also a noticeable absence of stones or bowlders over the type.

This soil occupies one continuous area in the northern part of the county. This area extends from a point about 6 miles north of St. Ansgar eastward about 4 miles. It narrows toward the north, but it is about 2 miles wide where it leaves the county. Several sand ridges traverse this area.

The Carrington loam as a whole endures wet weather better than most of the Carrington silt loam. Farmers state that in dry seasons crops on the sandy mounds may be affected, but that they are seldom seriously injured elsewhere. Nearly all this type is in condition for satisfactory tillage somewhat earlier than the adjoining heavier soils. In the late summer of 1916, which was unusually dry, the moisture content of the subsoil and substratum was apparently normal, or at least showed no marked deficiency of water.

All this type is in cultivation. The average yields of corn and oats seem to be about the same as on the Carrington silt loam. Clover does well on all parts of the type. Timothy thrives best in the heavier areas, particularly in dry seasons.

CARRINGTON SILT LOAM.

The surface soil of the Carrington silt loam to a depth of 10 or 12 inches is a very dark grayish brown to black silt loam. The subsoil to a depth of 25 or 30 inches from the surface is a rather light yellowish brown silty clay loam. The lower subsoil in most places is a brownish clay loam to sandy clay, containing more or less gravel. Some small stones are usually present within the 3-foot section, but these as well as any noticeable increase in sand and gravel are generally below the 3-foot depth. The substratum is quite variable in character, ranging from a compact clayey till to loose, coarse sand.

The color of the surface soil is due to its high content of organic matter, consisting of black carbonaceous material, which is more or less inert as a direct source of plant food, but which renders the soil friable and easily tilled.

The yellowish-brown subsoil is crumbly, and usually has a moderate degree of compactness, but never an impervious structure. It has excellent capillarity and the aeration is generally good, as is indicated by the uniformly brown color.

The black soil is usually acid, according to litmus-paper test, and the yellow subsoil is markedly acid in most places. Where the substratum consists of sand or sandy material, there is seldom any evidence of free lime, but in those areas having the stiff, bluish clay or till at a depth of 5 or 6 feet this deep material is often calcareous. Very little of this type shows any indication of free lime at less than 6 or 8 feet from the surface, and this is particularly true where the substratum consists of sandy or gravelly material.

The Carrington silt loam has an extensive distribution in this county, being the dominant type of the uplands and the prevailing soil in all the undulating to gently rolling areas.

The drainage of the greater part of the type is good, but there are many included patches that are poorly drained. In small local flats and along the small drainage ways there is more or less land that remains wet each spring until after the higher land is in condition for tillage. There are also small patches where an exceptionally heavy substratum retards the removal of excess water.

Some broad regional variations are recognized in this survey. West of the Cedar River most of this type is very gently undulating, and on almost every farm there is more or less land that would be benefited by tile drainage. It is only in wet seasons, however, that the necessity of such drainage becomes very apparent. East of Osage, on the upper branches of Spring Creek, there is also considerable land that has not sufficient relief to permit a rapid run-off of the rainfall.

In the vicinity of St. Ansgar on both sides of the river, the Carrington silt loam is underlain by lime rock at a depth of a few feet. Between the rock and the subsoil sandy material is generally present, and this insures good drainage. Where this condition exists the land admits of earlier cultivation than is practicable on the type some miles to the east and southeast of the town. In the northwestern part of the county between the Cedar and Little Cedar Rivers much of the type is underlain by rather coarse, brown sand. In the vicinity of the Carrington sandy loam areas, the silt loam contains somewhat more sand than elsewhere.

The wide depression in which Toeterville is located is remarkably free from poorly drained spots. The absence of these and the relatively few natural drainage channels south and southeast of Toeterville are evidently due to the presence of a deep sandy substratum.

For a mile or more to the east of the area of the Clinton silt loam the Carrington soil is very silty, and the substratum is a silty sand, or relatively clean sand, which gives good underdrainage. The limestone occurs at a rather shallow depth. The desirable properties of these loessial variations of the Carrington soil are attributed by farmers to the proximity of the lime rock. The thorough underdrainage and deep aeration induced by the sandy substratum is more probably the cause.

Most of the Carrington silt loam drained by the Little Cedar and Wapsipinicon Rivers is strongly undulating to gently rolling. There are many local divides and steep slopes where the soil contains more coarse material and less organic matter than typical. The subsoil is also coarser textured, particularly in the lower part, and lacks the uniformly porous, crumbly structure of the typical subsoil. In such

locations poorly drained spots are found, not only in the depressions but sometimes on slopes. The presence of a heavy substratum at slight depth is usually the cause of the poor drainage in such areas. Frequently the poorly drained spots occur well up on the slopes, or at the heads of local waterways.

All this type is admirably adapted to the use of labor-saving machinery. Large bowlders are not uncommon, but most of the smaller ones have been removed.

The average yield of corn is about 50 bushels per acre. Higher yields are obtained on the best farms, but yields of 80 to 90 bushels are rare. Ordinarily the yield of oats ranges from about 40 to 60 bushels.

Timothy does well on this type, and where trouble is experienced in getting a stand of clover it is attributed by farmers to weather rather than to soil conditions. Bluegrass comes in as a volunteer growth in permanent pastures and yards, and along roadsides. Wheat is said to have produced 20 to 30 bushels per acre, and the decline in yields does not seem to have been due to soil deterioration. The trucking industry near St. Ansgar is almost entirely confined to that part of this type that is well drained because of the predominance of silt in the 3-foot soil section and sand in the substratum.

Practically all the Carrington silt loam is in farms, the majority of which are well improved. The present price of land of this type in well-settled areas is about $150 an acre. Land that is unimproved or remote from towns is valued at $100 to $125 an acre.

The following table shows the results of the mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Carrington silt loam:

Carrington silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331504	Soil	0.1	2.0	2.8	8.8	16.0	50.6	19.6
331505	Subsoil	.1	2.3	3.6	10.5	26.8	43.8	12.8
331506	Lower subsoil	.2	2.9	4.2	14.0	34.5	34.0	10.2

CLYDE SILT LOAM.

To a depth of about 20 inches the Clyde silt loam is a very black silt loam or silty clay loam. The subsoil is a light-gray or mottled pale-yellowish and gray silty clay. It is usually smooth and sticky when wet, and assumes a pronounced granular structure on drying. In the lower part of the 3-foot soil section sandy clay or comparatively loose sand and gravel are encountered.

The type as mapped includes some small patches of Muck, and many patches with so high a proportion of organic matter in the

surface soil that it is mucky to a depth of several inches. It also includes semialluvial soils along the small branches and upper courses of the creeks. The larger areas near the heads of drainage ways are usually shallow basins with a perceptible slope toward the outlet. In these areas no sharp separation can be made between this soil and the higher lying Carrington silt loam.

A small part of this type is regularly cultivated, but in wet seasons efficient tillage is difficult. In normal seasons the ground is in condition for plowing a few weeks later than in case of the silt loam of the higher areas.

Much of this soil is artificially drained, and the results are highly satisfactory. All crops do well with the possible exception of oats, which tend to lodge badly in wet seasons.

This type differs from the Carrington silt loam, with which it is closely associated, in the higher content of carbonaceous material in the upper soil section, in the generally higher percentage of clay in the soil and subsoil, and in the higher average level of the ground water, even in the artificially drained areas. The soil is usually acid, and there is seldom any limestone or other calcareous material in the subsoil, but calcareous material often occurs at depths of 4 or 5 feet.

SHELBY SILT LOAM.

The surface soil of the Shelby silt loam is a dark grayish brown to black silt loam usually containing an appreciable quantity of sand and a few pebbles. At a somewhat variable depth, but generally at less than 8 inches, this dark-colored soil grades into a light-brown or yellowish-brown silt loam, friable in the upper part, but more compact below a depth of 15 or 20 inches. At this depth some coarse sand and gravel occur, the quantity increasing downward. At depths of 30 or 40 inches the subsoil is generally a brown or slightly reddish brown, sandy or gravelly clay.

This type occupies the rolling areas near the rivers and larger creeks. It is most likely to lie on the steeper slopes and the points of low ridges. On the sharper elevations and on the narrow ridges the surface soil is usually a loam to sandy loam carrying considerable gravel and some small stones. At a depth of a few inches the subsoil is a brown loam, often heavy and compact, but underlain at less than 3 feet by gravel and sand. All the subsoil, as well as the gravel, is well oxidized and has a pronounced brown to reddish-brown color. There is no evidence of free lime.

On nearly all the gentle slopes this type approaches in character the Carrington silt loam. In local depressions the black soil is deeper than elsewhere. The subsoil is usually heavier than that of the higher areas and may be somewhat lighter colored. There are

also small areas, usually on the hillsides, where the drainage is poor, and the soil is too wet much of the time for satisfactory cultivation. This seems to be due to the occurrence of a heavy substratum at a depth of a few feet. Borings with a 40-inch soil auger often reveal a heavy, light-colored clay as the lower subsoil, and farmers frequently report "blue clay" in such localities at shallow depths.

The largest areas of this soil are found west of the Little Cedar River. Smaller areas occur east of this stream and along its larger tributaries. The small, isolated areas are local elevations where the soil is more or less sandy and contains less organic matter than that of the lower ridges and gentler slopes.

The areas near the Cedar River are generally small. The type is associated with the Dodgeville silt loam, shallow phase. Small patches of the latter are included with this type. In nearly all instances this type has a stronger relief and more local variation in topography on the west than on the east side of the valleys. There is very little of it, however, that can not be farmed with machinery.

The average yields of crops are about the same as on the Carrington soils, with the exception of corn. The corn yields are somewhat lower. This is probably due to the low organic-matter content in the higher areas and to the less favorable drainage conditions of the richer soils of the lower areas.

This type commands about the same price per acre as the more rolling areas of the Carrington silt loam.

Much of this type would be benefited by growing clover more frequently in order to keep up the organic-matter supply. Some slopes show the effect of cultivation and of surface washing in the shallow depth at which the brown subsoil is encountered. There are also many places where tile drainage would be highly beneficial. Some of the small "seepy" spots would be improved by a line or two of tile across their upper limits to cut off the source of the water. A line of tile on each side of the longer "sloughs" would doubtless render most of these low places as tillable as the adjacent hillsides.

CLINTON SILT LOAM.

The surface soil of the Clinton silt loam is a very friable silt loam, ranging in color from rather ashy gray to dark gray. At a depth of about 8 inches the color changes to light brown with faint grayish mottlings. With increase in depth the gray usually disappears and the material is a brown silt loam or, in some instances, a silty clay loam, and is moderately compact though not impervious.

The lower part of the 3-foot soil section is generally a brown silt loam, containing considerable sand. The proportion of sand

rapidly increases with depth, and at 3 or 4 feet from the surface the material is a silty fine sand or a somewhat coarser sand with very little fine material.

In uncleared areas there is considerable organic matter in the surface few inches. In the cultivated fields the organic-matter content is so low that the soil is gray or very light brown. It is very acid, and as a rule the subsoil does not effervesce in hydrochloric acid. At a depth of several feet slightly calcareous material is sometimes found.

Only one considerable area of the Clinton silt loam occurs in this county. This forms a belt about 1 mile in width on the east side of the Cedar River between Mitchell and Orchard. A few small areas occur on the west side of the river. These areas have a heavier subsoil, consisting usually of a stiff, sandy clay similar to the corresponding section of the Carrington silt loam.

The topography of most of the type is gently rolling. Long, evenly rounded ridges, having a northwest-southeast trend, are a characteristic feature. South of Osage some of the type nearest the river consists of rounded knolls, or mounds. Limestone sinks are common and there are occasional rock outcrops.

This type is well drained. The structure, 3 or 4 feet of silt underlain by sand, is highly favorable to good underdrainage and deep aeration. The material to a depth of several yards has the uniform brown color indicative of a rather high degree of oxidation. The structure of the subsoil also favors the free capillary movement of moisture between the surface soil and the sandy substratum. Farmers state that crops do not usually suffer from drought on well-tilled land. Nearly all this type was originally forested. The rougher sections now have a more or less scattered growth of trees, but most of the areas are in cultivation.

Corn yields from 40 to 50 bushels per acre. Oats give about the same yield, and stand up better and are less affected by excessive rainfall than on the typical Carrington silt loam. Red clover, white clover, timothy, and bluegrass do well, but the growth is not so luxuriant as on the black soils. It is stated by some farmers that the quality of the crops grown on this type, as well as on the lighter colored part of the adjoining Carrington silt loam, is better than that of similar crops on soils richer in organic matter. This is in accord with experience on the gray and black soils of Indiana, though the difference in Mitchell County may not be as pronounced as in areas studied in Indiana. Some sugar beets and potatoes are grown on this type near Osage.

Deep loess soils are well adapted to tree fruits, and this type affords favorable sites for orchards.

DODGEVILLE SILT LOAM, SHALLOW PHASE.

The Dodgeville silt loam, shallow phase, is variable. It includes those areas in which the lime rock is encountered at depths of less than 3 or 4 feet from the surface. A representative section consists of 6 or 8 inches of black silt loam, gradually changing with depth to dull brownish silt loam or silty clay loam. This assumes a more pronounced brown color at 20 to 30 inches below the surface. The lower subsoil is frequently a compact brown or reddish-brown sandy clay, carrying some more or less rounded rock fragments of various kinds, and fragments of the lime rock. In a few places the lower subsoil consists of residual material and is either a yellowish, sticky, somewhat sandy clay, or a stiff, brown, granular clay, seldom more than a few inches in thickness. The soil is generally acid; the subsoil is neutral or calcareous.

The soil and subsoil of the deeper areas resemble the corresponding sections of the Carrington silt loam, and are apparently identical in origin and character of material. The agricultural value is about the same, except near outcrops of the rock, or where the latter is so close to the surface that the soil is droughty.

The deeper and more productive soil prevails in the wider areas. The soil in the narrow areas of the phase is more variable. These areas include many steep slopes of little agricultural value except for pasture. On the Cedar River they include the blufflike escarpment of the uplands and the many limestone cliffs that occur along the stream from Mitchell southward.

LINDLEY SILT LOAM.

The Lindley silt loam of this area is of variable character. In most places the soil is a light-gray silt loam, pasty when wet and loose and floury when dry. The upper subsoil is a compact silt to silty clay loam, ranging in color from gray to light brown. In many instances it is more or less mottled with various shades of the above colors. The lower subsoil is usually a brown or yellowish-brown sandy clay, and contains more or less stony material. In some places it is unfavorable to good underdrainage, and seepy spots occur on the slopes. As a rule the higher land is better drained, and the soil has a darker color than the lower land. The type was originally forested, and has a low organic-matter content.

The area near Riceville is variable, the soil ranging from light gray or ashy on the hilltops near the river to dark colored along the county boundary where it merges with the Carrington silt loam. Most of this land is used for pasture. The darker colored areas are satisfactorily tilled, but are not so productive as the Carrington soil. The small areas on lower Rock Creek are essentially a forested phase of the Carrington silt loam.

WAUKESHA SILT LOAM.

The surface soil of the Waukesha silt loam, to a depth of 10 or 12 inches, is a silt loam varying in color from very dark gray to black. It usually contains an appreciable quantity of sand and some gravel. The subsoil is a yellowish-brown or, in many instances, pale-yellowish silty clay loam, which grades at depths of 20 to 30 inches into a gravel substratum, consisting chiefly of well-rounded pebbles and coarse sand and extends to an undetermined depth.

This type occurs on the terraces or high second bottoms of the rivers and along lower Rock Creek and a few other large creeks. The surface is level, or nearly so, except along the base of the adjacent hills where it may have a slight slope. The margin of the terraces near the streams is usually a sharp, gravelly descent of 15 to 25 feet.

On the Little Cedar and Wapsipinicon Rivers the type includes wide areas of level land where the surface features and drainage conditions are quite uniform. This is true also of the greater part of the smaller areas along Rock Creek, although in these areas the depth to the gravel is somewhat variable. The areas along the Cedar River are small and of variable elevation above the first bottom, and the surfaces are usually rather uneven. The soil ranges from a silt loam to sandy loam, but generally has good moisture-holding properties.

In the largest areas of the type the depth to gravel is greatest near the uplands, where it may be 3 or 4 feet, and least at the margin of the terrace, where it may be less than 20 inches. In all instances the gravel affords good underdrainage and aeration.

The clayey subsoil is usually rather plastic, and in places so compact that it prevents satisfactory underdrainage where the substratum is less gravelly. In many places in the larger areas there are spots where the pale-yellowish color of the subsoil indicates rather slow underdrainage, but there is seldom serious injury to crops from such a cause.

Owing to its silty texture and high content of black, carbonaceous material, the surface soil is friable and easily cultivated. It is acid according to litmus-paper tests.

Practically all the Waukesha silt loam is in farms, and the average yields of the leading crops are comparable with those obtained on the Carrington silt loam. As a rule the soil is in condition for tillage earlier in the spring than the upland soils. It also dries more rapidly after rains. Except along the margins of the terraces where the gravel may be very near the surface, this type retains moisture well.

Fruit trees and the various coniferous and deciduous trees in shelter belts make about as good a growth as on the uplands. Crops

are somewhat more subject to injury by early frosts on this type than on higher land.

The present value of this land is about $150 an acre.

In the following table are shown the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Waukesha silt loam:

Waukesha silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331519	Soil	2.0	7.2	5.8	10.6	8.0	52.4	14.2
331520	Subsoil	4.1	8.8	6.1	13.3	8.9	43.3	15.5
331521	Lower subsoil	5.0	14.3	13.5	33.0	7.7	16.0	10.4

BREMER SILT LOAM.

The soil of the Bremer silt loam is a black silt loam with a high content of organic matter, usually extending to a depth of 15 or 20 inches. The lower part of this black soil is frequently a rather heavy, granular silty clay. Below the influence of the vegetable matter the material is light drab, or very light yellowish gray with some mottling of various shades of yellow and brown. With increase in depth the material usually becomes denser and less permeable to air and water. In places it is a gray, gravelly, sticky clay, or there may be a thin layer of bluish-gray clay containing no gravel, but underlain at a depth of a few feet by loose, coarse water-bearing sand and gravel.

The poor drainage is due largely to the impervious nature of the substratum, but the lack of surface relief is a contributing cause. The abundance of organic matter in the upper part of the 3-foot section, and the granular structure of the lower part indicate normal soil conditions, excepting the slow drainage. With artificial drainage this should prove a good soil for general farming.

Small areas of this type occur in a few places in the Wapsipinicon Valley. The largest area is mapped south of McIntire. The type is used chiefly for pasture.

PLAINFIELD LOAM.

The soil of the Plainfield loam is a silty loam usually containing a high percentage of sand and some gravel. The color ranges from moderately dark gray to light brown. At a depth of a few inches the material usually changes to a light-brown loam or silt loam, which is very friable and has an open structure. At a somewhat variable depth, but usually at less than 18 or 20 inches, coarse, loose

sand and gravel are encountered. This material extends to depths of many feet.

The Plainfield loam occurs on the outer, or riverward, margin of the terraces. In many instances it forms a narrow border along areas of the Waukesha silt loam. As mapped the strips include stony, gravelly slopes of the terrace. In the wider areas the soil varies considerably in depth and ranges from a black silty loam in uncleared pastures to a gray soil in cultivated fields where coarser materials are much more in evidence. In the latter situations the organic-matter content is low and the soil is acid. Lime fragments seldom occur in the subsoil.

Most of this type is droughty and a large part of it is used only for pasture. The deeper areas produce fair crops in normal seasons, but a prolonged period of dry weather seriously affects tilled crops and also the grasses.

CHARITON SILT LOAM.

The surface soil of the Chariton silt loam is a dark-gray to ashy-gray silt loam, usually containing considerable fine sand. At a depth of 4 or 5 inches this passes abruptly into a light-gray or very pale yellowish gray silt loam, which is very friable when dry and almost entirely lacking in granular structure. At a variable depth, but usually at 18 or 20 inches, the material is a compact silty clay, carrying some coarse, angular sand and small pebbles. The material is usually sticky and rather impervious throughout the remainder of the 3-foot soil section, but at about 40 or 50 inches from the surface it contains more or less gravel, and grades downward into coarse, water-bearing sand and gravel.

The areas of this type near Bailey and McIntire conform to this description. They occupy terraces with a gentle inclination from the uplands toward the Wapsipinicon River. The elevation above the stream ranges from about 20 to 40 feet. The surface drainage in places is slow, owing to the nearly flat surface, but over a large part of these areas there is sufficient slope to give a fairly good run-off of storm waters. The poor drainage is due also in part to the heavy subsoil or in some places to the occurrence of a compact clay below the 3-foot section.

The small areas of this soil about 2 miles south of Riceville differ somewhat from the typical. The surface soil and upper subsoil generally consist of a light-colored silt loam, overlying rather coarse sand and gravel. At a depth of 3 or 4 feet a compact, clayey till is encountered, and this, judging from some exposures on the east bank of the river in the southwestern part of section 1, is of great thickness and is unfavorable to good underdrainage. In a small area

on the opposite bank of the river, section 12, where substrata of similar structure prevail, tile drains have been laid and the land is satisfactorily cultivated. Formerly the area was very wet.

Most of this type is used for the production of timothy hay. Usually more or less redtop becomes mixed with the timothy, and in places other native moisture-loving grasses appear. Clover does not do well. Oats give good yields in the better drained areas, provided the season is not too wet. Owing to the lack of organic matter in the soil, its acidity, and the uncertain moisture conditions this type is not considered safe for cultivated crops. In pastures coarse grasses are common and patches of aspen trees and alder bushes occur.

The price of most of this land ranges from $40 to $50 an acre; in some cases the type has a higher value.

All this type could probably be greatly improved by tile drainage. Where a very heavy subsoil prevails, it will be necessary to place the laterals rather close together. There is some evidence that the dense clay subsoil and substratum in places rests upon deep gravel beds. In such places vertical drains or "wells" sunk to the underlying gravel might prove effective.

In the following table are shown the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Chariton silt loam:

Mechanical analyses of Chariton silt loam.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331528, 331537.....	Soil.....	0.3	3.6	3.1	9.2	13.2	57.1	13.1
331529, 331538.....	Subsoil.....	1.2	4.6	4.7	14.8	22.4	36.1	16.0
331530, 331539.....	Lower subsoil.....	1.2	4.6	4.7	14.8	22.4	36.1	16.0

CASS SANDY LOAM.

The Cass sandy loam typically is a rather coarse textured sandy loam, ranging in color from grayish brown to black. As a rule there is not much difference between the surface soil and subsoil, except that the latter is usually a grayish-brown material a little more coherent than the former. Below the 3-foot section a coarse, brown sand usually occurs.

The narrow areas of this type along the Cedar River are generally a light sandy loam. The wider areas are usually a black sandy loam or loam, becoming heavier near the foot of the adjoining hillside. The organic-matter content is relatively large in most instances and affects the color to a depth of 18 or 20 inches. Very frequently

coarse, clean sand grains are a noticeable feature of these otherwise very dark colored soils. All the type is subject to overflow, generally in the spring. Much of this land is regularly tilled, and produces good yields of corn, potatoes, and oats.

In the following table are shown the results of mechanical analyses of samples of the soil, subsoil, and lower subsoil of the Cass sandy loam:

Mechanical analyses of Cass sandy laom.

Number.	Description.	Fine gravel.	Coarse sand.	Medium sand.	Fine sand.	Very fine sand.	Silt.	Clay.
		Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
331543	Soil	0.4	8.4	16.4	44.0	12.9	15.3	2.4
331544	Subsoil	.4	9.7	16.0	40.8	15.0	16.2	2.8
331545	Lower subsoil	.1	7.3	14.7	40.5	17.1	16.7	3.7

CASS SILT LOAM.

The Cass silt loam is a very dark brown to black soil ranging in texture from a loam to rather heavy silt loam. The content of organic matter is generally high, and affects the color to a depth of 18 or 20 inches. The subsoil is usually a dull brownish, silty material containing more sand than the surface soil. In places, particularly in rather low areas near the foot of the upland slopes, the subsoil may be a drab to very dark brownish silty clay. As a rule, however, the lower part of the 3-foot section is rather coarse textured, and the underdrainage is fair when the streams are at normal stage.

The largest areas of this type are found in the Little Cedar River Valley. Small areas occur along the Cedar River and along the Wapsipinicon River, but those along the latter stream are mainly included with Meadow, on account of their small size.

The areas along the Little Cedar River lie, for the most part, above the reach of ordinary overflow, but are inundated during exceptionally high floods. The surface is slightly uneven, there being many remnants of old channels. Most of these areas are used chiefly for pasture, but except for the danger of overflows are well adapted to tilled crops. Between flood periods the drainage is usually good.

The areas above Osage on Cedar River comprise black, silty soil and lie well above overflow. The small areas elsewhere in this valley are more or less sandy and are subject to overflow. All are highly productive and give good yields of grass, corn, and potatoes.

MUCK.

Only a few areas of Muck of sufficient extent to be mapped satisfactorily are found in this county. The largest area is about 7 miles west of Osage, on a branch of Rock Creek. The material con-

sists of a stratum of black, finely divided vegetable remains, varying in thickness from a few inches to several feet. It is underlain by clay or sandy clay. The lime rock occurs in a few places at a comparatively shallow depth and possibly is one cause of the obstructed drainage to which the areas of Muck owe their origin. Smaller areas occur on upper Rock Creek and in various places on the upland in other parts of the county. In all instances the depth of the black, carbonaceous material is greatest near the center of the area, but usually does not exceed 3 or 4 feet.

The areas in the northwestern corner of the county near the Cedar River occur on a slightly elevated part of the bottom land. The material consists of several feet of nearly pure Muck, resting upon calcareous clay. Small patches, rarely exceeding a few acres, are found in all the river valleys. These are of little economic value. There is also considerable mucky land in the poorly drained areas of the Clyde silt loam.

Shallow Muck underlain by clay has proved in the Eastern States more satisfactory under tillage than similar deposits resting upon sand. In the former more or less earthy material is mixed with the vegetable remains, and the potash supply is doubtless better than where sand constitutes the substratum. Drainage is the main factor in determining the agricultural value of mucky soils, and the high moisture-retaining power of the material sometimes renders satisfactory drainage too expensive where ordinary crops are to be grown. Corn on the Muck areas is generally of poor quality and oats are difficult to harvest on account of their tendency to lodge. Good yields of wheat and barley are reported in some areas. The safest use of Muck seems to be for bluegrass and timothy, both of which are adapted to such land without as thorough reclamation as is necessary for grain or truck crops.

MEADOW.

The areas mapped as Meadow comprise alluvial soils of such variable character that no separation into types is practicable. The areas along the Cedar River comprise the higher banks of the streams. They consist of sandy material which in the wider parts of the flood plains is a black sandy loam. Most of this land is only partly covered with trees and affords considerable pasture.

Along the Little Cedar River Meadow occurs in larger areas and is generally a black sandy loam or silt loam. The surface is intersected by many old channels, and Muck beds occur in some places. All the land is subject to overflow and used almost entirely for pasture. The timber is generally small and confined to the immediate river banks.

All the narrow, uneven flood plain of the Wapsipinicon River is indicated on the soil map as Meadow. In a few places small tillable areas of silty soil occur, but very few of these are in cultivation on account of the frequent occurrence of overflows. In the "loops" of the crooked channel elm, maple, and ash trees often form dense groves, but elsewhere the timber is scattered and bluegrass thrives, affording good pasturage.

SUMMARY.

Mitchell County lies in the northern part of Iowa. It has an area of 467 square miles, or 298,880 acres.

Nearly all the surface is undulating to very gently rolling upland. The Cedar, Little Cedar, and Wapsipinicon Rivers cross the county from northwest to southeast. Their valleys are narrow, and the areas of alluvial and terrace soils are of small extent.

The total population of Mitchell County is given in the 1910 census as 13,435. Osage, the county seat, is the largest town, with a population of about 2,500, as reported in 1910. Transportation facilities are good.

The county has a mean annual rainfall of about 31 inches; the mean annual temperature is reported as about 44° F. There is a normal growing season of about 164 days. In general, the climate is favorable for agriculture.

The county is well developed agriculturally; the farms are generally large and labor-saving machinery is in universal use. An extensive system of farming is generally practiced.

Corn, oats, timothy, and clover are the principal crops. Wheat and barley are grown to some extent, and rye, flax, and buckwheat are produced in a small way. Near St. Ansgar, Irish potatoes, onions, and cabbage are grown to such an extent as to make that point locally important as a trucking center. Some cattle are fattened. A large number of hogs and some sheep are raised in the county, and dairying is locally important.

Little attention is given to systematic crop rotation, and practically no commercial fertilizers are used. Over two-thirds of the farms are operated by the owners. According to the census of 1910, about 97 per cent of the area of the county is in farms, and of the farm land about 91 per cent is improved. The average size of the farms is given as 151 acres, and the average assessed value of farm land in 1910 at about $68 an acre.

The soils are derived from glacial or glacial-loessial material of the Iowan drift. The dominant types are black silt loams of high agricultural value.

The Carrington soils are the most extensive in the county. The silt loam type comprises 74.4 per cent of the entire area of the

county. This is a black silt loam with a yellowish-brown subsoil. It is admirably adapted to general farming.

The Clyde silt loam is found in local depressions and along the minor drainage ways. It is in need of artificial drainage, but otherwise is very desirable for general farming.

The Shelby silt loam, which has a much stronger relief than the other upland types, has generally less organic matter, and includes gravelly patches. All the type is tillable, and it produces good crops.

The Clinton silt loam is a light-colored, formerly timbered soil, occurring in the loess area just east of the Cedar River Valley. It is relatively low in organic matter, possesses good physical properties, is very easily tilled, and produces good crops.

The Dodgeville silt loam, shallow phase, is very similar to the black silt loams, except that the limestone is generally encountered within 3 or 4 feet of the surface.

The Lindley silt loam is variable; prevailingly it is light gray, although some areas are darker colored. The type is mainly in pasture.

The Waukesha silt loam is the dominant type of the terraces, or high second bottoms. It is a black soil with a yellow or brown silty clay subsoil underlain by deep gravel beds. Practically all this type is in cultivation; it is highly esteemed for general farming.

The Bremer silt loam is a black, poorly drained soil which with artificial drainage should prove well suited to general farming. It is used chiefly for pasture.

The Plainfield loam and Chariton silt loam are terrace soils of small extent. The former is a shallow loam overlying loose gravel. The Chariton silt loam is poorly drained, owing to its impervious subsoil.

The small areas of alluvial soils classed with the Cass series are black sandy or silty loams of high productiveness. They are mainly in cultivation.

Most of the recent alluvial deposits are mapped as Meadow. They are subject to overflow, and are not generally of agricultural value except for pasture. A few small areas of Muck are mapped. These seem best adapted to pasture.

○

[PUBLIC RESOLUTION—No. 9.]

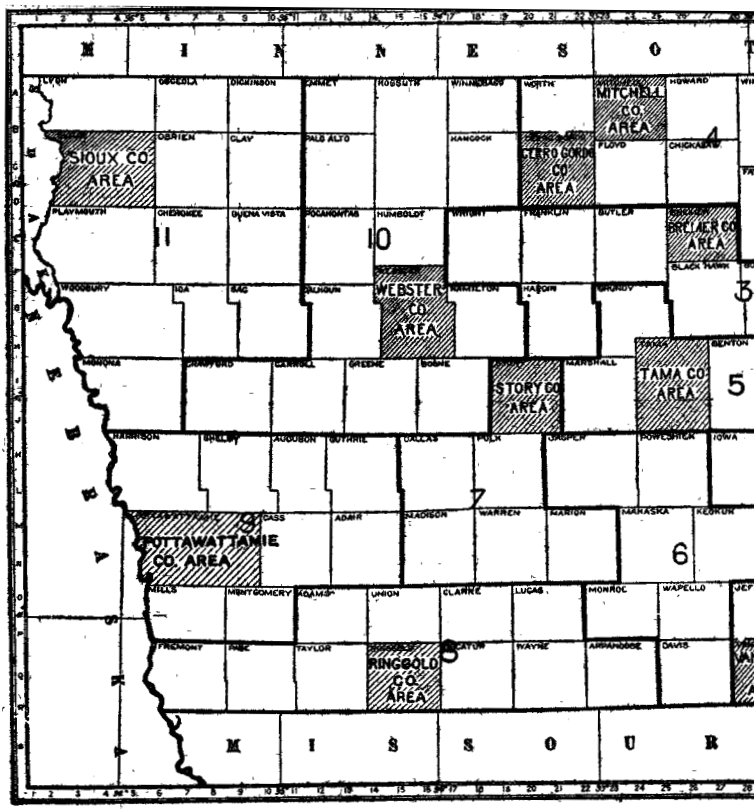
JOINT RESOLUTION Amending public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, "providing for the printing annually of the report on field operations of the Division of Soils, Department of Agriculture."

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That public resolution numbered eight, Fifty-sixth Congress, second session, approved February twenty-third, nineteen hundred and one, be amended by striking out all after the resolving clause and inserting in lieu thereof the following:

That there shall be printed ten thousand five hundred copies of the report on field operations of the Division of Soils, Department of Agriculture, of which one thousand five hundred copies shall be for the use of the Senate, three thousand copies for the use of the House of Representatives, and six thousand copies for the use of the Department of Agriculture: *Provided*, That in addition to the number of copies above provided for there shall be printed, as soon as the manuscript can be prepared, with the necessary maps and illustrations to accompany it, a report on each area surveyed, in the form of advance sheets, bound in paper covers, of which five hundred copies shall be for the use of each Senator from the State, two thousand copies for the use of each Representative for the congressional district or districts in which the survey is made, and one thousand copies for the use of the Department of Agriculture.

Approved, March 14, 1904.

[On July 1, 1901, the Division of Soils was reorganized as the Bureau of Soils.]



Areas surveyed in Iowa.

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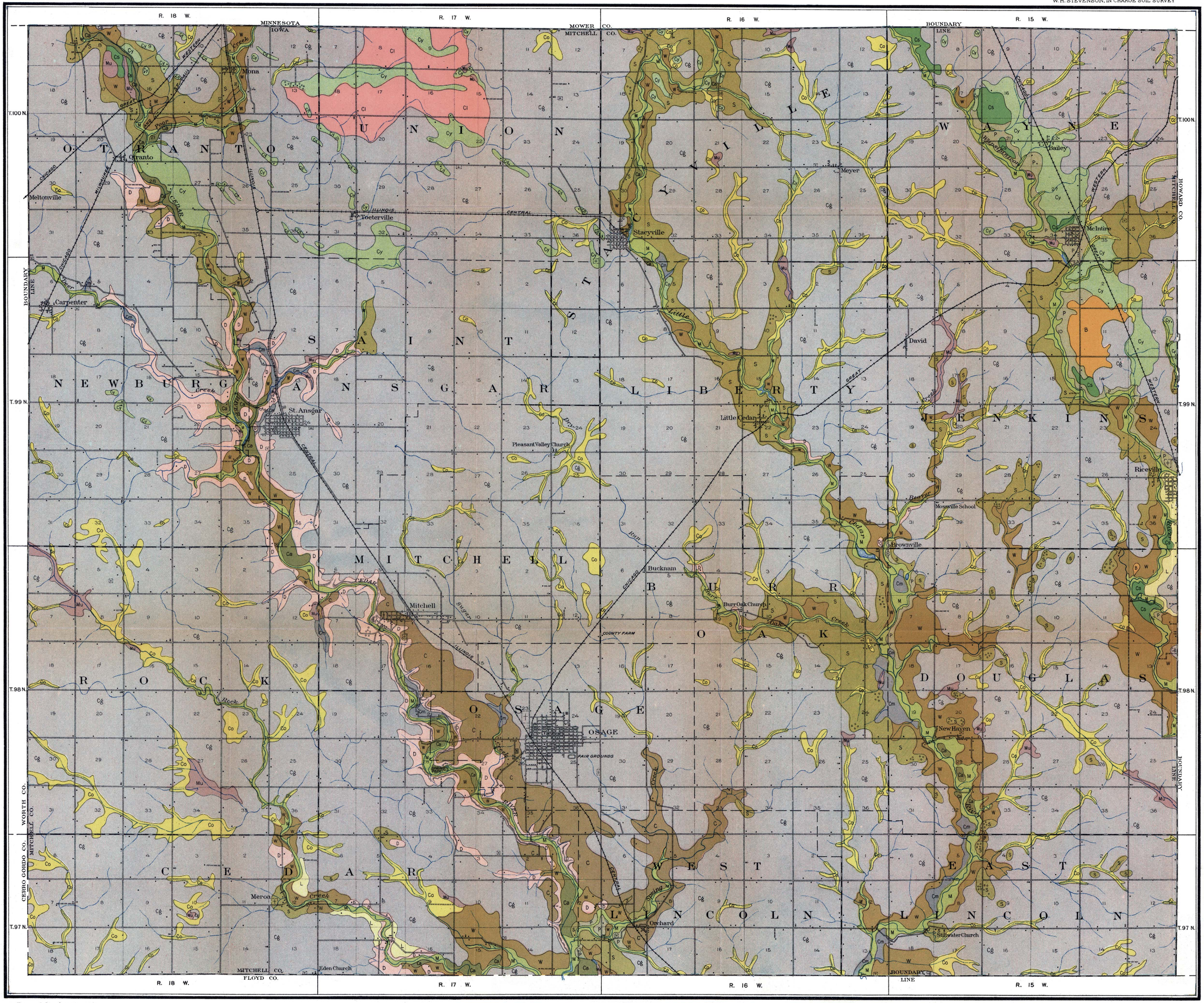
U. S. DEPT. OF AGRICULTURE
BUREAU OF SOILS
MILTON WHITNEY, CHIEF
CURTIS F. MARBUT, IN CHARGE SOIL SURVEY

SOIL MAP
IOWA
MITCHELL COUNTY SHEET

IOWA AGRICULTURAL EXPERIMENT STATION
C. F. CURTISS, DIRECTOR.
W. H. STEVENSON, IN CHARGE SOIL SURVEY



LEGEND

Carrington sandy loam — Cy	Clinton silt loam — C
Carrington loam — Cl	Dodgeville silt loam Shallow phase — D
Carrington silt loam — Cg	Lindley silt loam — L
Cass sandy loam — Ca	Waukesha silt loam — W
Cass silt loam — Cm	Bremer silt loam — B
Clyde silt loam — Co	Plainfield loam — P
Shelby silt loam — S	Chariton silt loam — Cs
Muck — Mu	Meadow — M

CONVENTIONAL SIGNS

CULTURE
(Printed in black)

City or Village, Roads, Buildings, Wharves, Jetties, Breakwater, Levee, Lighthouse, Fort.

Secondary roads and trails

Railroads: Double track, Single track, Interurban in road; Steam and Electric

Bridges, Ferry

R.R. crossings, Tunnel: R.R. above, R.R. below

Ford, Dam

School or Church, Cemeteries: CEM

Mine or Quarry, Mine dumps, Made land

Bluff, Escarpment, Rock outcrop and Triangulation station

Stony and Gravelly areas

Soil boundaries

Boundary lines: State, County

Boundary lines: Land grant, City or Village

Boundary lines: Civil township, Reservation

U.S. township and section lines

RELIEF
(Printed in brown or black)

Contours, Depression contours

Prominent Hills, Mountain Peaks

Sand, Wash, and Sand dunes

Shore and Low-water line, Sandbar

DRAINAGE
(Printed in blue)

Streams

Lakes, Ponds, Intermittent lakes

Intermittent Streams

Springs, Canals and Ditches, Flumes

Swamp, Salt marshes

Submerged marsh, Tidal flats

The above signs are in current use on the soil maps. Variations from this usage appear in some maps of earlier dates.

Thomas D. Rice, Inspector, Northern Division.
Soils surveyed by W. E. Tharp, of the U.S. Department of Agriculture, in charge, and Knute Espe, of the Iowa Agricultural Experiment Station.

Scale 1 inch = 1 mile
1 ½ 0 1 2 3 4 Miles

SNYDER & BLACK, N.Y.

Field Operations
Bureau of Soils
1916